

WHAT IS CLAIMED AS NEW AND DESIRED TO BE SECURED BY LETTERS
PATENT OF THE UNITED STATES IS:

1. A valve manifold for a pressure swing adsorption system having at least one pressure vessel, said valve manifold comprising:

a body having a first cavity, a first passage and a first channel, said first cavity being adapted to fluidly connect to the at least one pressure vessel, said first passage connecting said first channel to said first cavity; and

a first valve provided within said first passage, said first valve being configured to selectively permit and restrict flow between said first channel and said first cavity via said first passage.

2. The valve manifold according to Claim 1, wherein:

said body has a second passage and a second channel, said second passage connecting said second channel to said first cavity; and

said valve manifold further comprises a second valve provided within said second passage, said second valve being configured to selectively permit and restrict fluid flow between said second channel and said first cavity.

3. The valve manifold according to Claim 2, wherein said first channel and said second channel are configured to provide a parallel flow connection to said first cavity.

4. The valve manifold according to Claim 2, wherein said first channel and said second channel are connected to a same side of said first cavity.

5. The valve manifold according to Claim 1, wherein:

said body has a second passage connecting said first channel to said first cavity; and

said valve manifold further comprises a second valve provided within said second passage, said second valve being configured to selectively permit and restrict fluid flow

between said first channel and said first cavity via said second passage.

6. The valve manifold according to Claim 5, wherein:

said body has a second channel and a third passage, said third passage connecting said second channel to said first cavity; and

said valve manifold further comprises a third valve provided within said third passage, said third valve being configured to selectively permit and restrict fluid flow between said second channel and said first cavity via said third passage.

7. The valve manifold according to Claim 1, further comprising:

a second cavity in said body adapted to fluidly connect to another pressure vessel, said body having a second passage connecting said first channel to said second cavity; and

a second valve provided within said second passage, said second valve being configured to selectively permit and restrict flow between said first channel and said second cavity.

8. The valve manifold according to Claim 7, wherein:

said body has a second channel, a third passage and a fourth passage, said third passage connecting said second channel to said first cavity, said fourth passage connecting said second channel to said second cavity;

said valve manifold further comprises a third valve provided within said third passage, said third valve being configured to selectively permit and restrict flow between said second channel and said first cavity; and

said valve manifold further comprises a fourth valve provided within said fourth passage, said fourth valve being configured to selectively permit and restrict flow between said second channel and said second cavity.

9. The valve manifold according to Claim 8, wherein said first channel and said

second channel are configured to provide a parallel flow connection between said first cavity and said second cavity.

10. The valve manifold according to Claim 1, wherein said first valve is configured to not restrict flow along said first channel.

11. The valve manifold according to Claim 1, wherein said first valve is configured to not restrict flow within said cavity.

12. The valve manifold according to Claim 1, wherein said body further comprises a sensor port connected to said cavity.

13. The valve manifold according to Claim 1, wherein said body further comprises a sensor port connected to said first passage.

14. The valve manifold according to Claim 1, wherein said body further comprises a sensor port connected to said first channel.

15. The valve manifold according to Claim 1, wherein;
said valve manifold is adapted to be rigidly connected to the at least one pressure vessel; and

said valve manifold further comprises a mounting boss having a pin journal adapted for connection to a support structure.

16. The valve manifold according to Claim 1, wherein said first passage includes a valve seat and a valve port in which said first valve is received.

17. The valve manifold according to Claim 16, wherein said valve seat is concentric with said valve port.

18. The valve manifold according to Claim 1, wherein said first valve includes a valve seal configured to be selectively actuated between a sealed contact position with a valve seat in said first passage wherein said first channel is sealed from said first cavity and a

non-contact position with said valve seat, said first valve further including a secondary seal member having a metering orifice.

19. The valve manifold according to Claim 1, wherein said first valve comprises:
a non-return valve;
a metering orifice provided in parallel with said non-return valve; and
an on/off valve provided in series with said non-return valve and said metering orifice.

20. The valve manifold according to Claim 19, wherein:
said non-return valve comprises a seal cup configured to receive said on/off valve therein;
said metering orifice is provided through said seal cup; and
said seal cup is spring biased toward a valve seat provided in said first passage.

21. The valve manifold according to Claim 19, wherein said first valve includes a motive device configured to linearly actuate said on/off valve in contact with and out of contact with a valve seat provided in said first passage.

22. A valve manifold for a pressure swing adsorption system having at least one pressure vessel, said valve manifold comprising:
a body having a cavity, a passage and a channel, said cavity being adapted to fluidly connect to the at least one pressure vessel, said passage connecting said channel to said cavity; and

means for selectively permitting and restricting fluid flow between said channel and said cavity.

23. A pressure swing adsorption system comprising:
a first pressure vessel having a first opening; and

a first valve manifold comprising:

a first body having a first cavity, a first passage and a first channel, said first cavity being fluidly connected to said first opening of said first pressure vessel, said first passage connecting said first channel to said first cavity; and

a first valve provided within said first passage, said first valve being configured to selectively permit and restrict flow between said first channel and said first cavity via said first passage.

24. The pressure swing adsorption system according to Claim 23, wherein:

said first body has a second passage and a second channel, said second passage connecting said second channel to said first cavity; and

said first valve manifold further comprises a second valve provided within said second passage, said second valve being configured to selectively permit and restrict fluid flow between said second channel and said first cavity.

25. The pressure swing adsorption system according to Claim 24, wherein said first channel and said second channel are configured to provide a parallel flow connection to said first cavity.

26. The pressure swing adsorption system according to Claim 24, wherein said first channel and said second channel are connected to a same side of said first cavity.

27. The pressure swing adsorption system according to Claim 23, wherein:

said first body has a second passage connecting said first channel to said first cavity;
and

said first valve manifold further comprises a second valve provided within said second passage, said second valve being configured to selectively permit and restrict fluid flow between said first channel and said first cavity via said second passage.

28. The pressure swing adsorption system according to Claim 27, wherein:

said first body has a second channel and a third passage, said third passage connecting said second channel to said first cavity; and

said first valve manifold further comprises a third valve provided within said third passage, said third valve being configured to selectively permit and restrict fluid flow between said second channel and said first cavity via said third passage.

29. The pressure swing adsorption system according to Claim 23, further comprising a second pressure vessel having a second opening, wherein said first valve manifold further comprises:

a second cavity in said first body being fluidly connected to said second opening of said second pressure vessel, said first body having a second passage connecting said first channel to said second cavity; and

a second valve provided within said second passage, said second valve being configured to selectively permit and restrict flow between said first channel and said second cavity.

30. The pressure swing adsorption system according to Claim 29, wherein:

said first body has a second channel, a third passage and a fourth passage, said third passage connecting said second channel to said first cavity, said fourth passage connecting said second channel to said second cavity;

said first valve manifold further comprises a third valve provided within said third passage, said third valve being configured to selectively permit and restrict flow between said second channel and said first cavity; and

said first valve manifold further comprises a fourth valve provided within said fourth passage, said fourth valve being configured to selectively permit and restrict flow between

said second channel and said second cavity.

31. The pressure swing adsorption system according to Claim 30, wherein said first channel and said second channel are configured to provide a parallel flow connection between said first cavity and said second cavity.

32. The pressure swing adsorption system according to Claim 29, wherein:

said first valve is configured to not restrict flow along said first cavity;

said first valve is configured to not restrict flow along said first channel;

said second valve is configured to not restrict flow along said second cavity; and

said second valve is configured to not restrict flow along said first channel.

33. The pressure swing adsorption system according to Claim 23, further comprising:

a second pressure vessel having a second opening; and

a second valve manifold comprising:

a second body having a second cavity, a second passage and a second channel, said second cavity being fluidly connected to said second opening of said second pressure vessel, said second passage connecting said second channel to said second cavity, said second channel being in fluid connection with said first channel; and

a second valve provided within said second passage, said second valve being configured to selectively permit and restrict flow between said second channel and said second cavity via said second passage.

34. The pressure swing adsorption system according to Claim 33, wherein:

said first body has a third channel and a third passage, said third passage connecting said third channel to said first cavity;

said first valve manifold further comprises a third valve provided within said third passage, said third valve being configured to selectively permit and restrict flow between said

third channel and said first cavity;

said second body has a fourth channel and a fourth passage, said fourth passage connecting said fourth channel to said second cavity, said fourth channel being in fluid connection with said third channel; and

said second valve manifold further comprises a fourth valve provided within said fourth passage, said fourth valve being configured to selectively permit and restrict flow between said fourth channel and said second cavity.

35. The pressure swing adsorption system according to Claim 34, wherein said fluid connection between said first and second channels and said fluid connection between said third and fourth channels are configured to provide a parallel flow connection between said first cavity and said second cavity.

36. The pressure swing adsorption system according to Claim 33, wherein:

said first valve is configured to not restrict flow along said first cavity;

said first valve is configured to not restrict flow along said first channel;

said second valve is configured to not restrict flow along said second cavity; and

said second valve is configured to not restrict flow along said second channel.

37. The pressure swing adsorption system according to Claim 33, further comprising:

a third pressure vessel having a third opening; and

a third valve manifold comprising:

a third body having a third cavity, a third passage and a third channel, said third cavity being fluidly connected to said third opening of said third pressure vessel, said third passage connecting said third channel to said third cavity, said third channel being in fluid connection with said first channel and said second channel; and

a third valve provided within said third passage, said third valve being

configured to selectively permit and restrict flow between said third channel and said third cavity via said third passage.

38. The pressure swing adsorption system according to Claim 37, wherein:
said first valve is configured to not restrict flow along said first cavity;
said first valve is configured to not restrict flow along said first channel;
said second valve is configured to not restrict flow along said second cavity;
said second valve is configured to not restrict flow along said second channel;
said third valve is configured to not restrict flow along said third cavity; and
said third valve is configured to not restrict flow along said third channel.

39. The pressure swing adsorption system according to Claim 23, wherein said first valve is configured to not restrict flow along said first channel.

40. The pressure swing adsorption system according to Claim 23, wherein said first valve is configured to not restrict flow within said first cavity.

41. The pressure swing adsorption system according to Claim 23, wherein said first body further comprises a sensor port connected to said first cavity.

42. The pressure swing adsorption system according to Claim 23, wherein said first body further comprises a sensor port connected to said first passage.

43. The pressure swing adsorption system according to Claim 23, wherein said first body further comprises a sensor port connected to said first channel.

44. The pressure swing adsorption system according to Claim 23, wherein;
said first valve manifold is rigidly connected to said first pressure vessel; and
said first valve manifold further comprises a first mounting boss having a pin journal adapted for connection to a support structure.

45. The pressure swing adsorption system according to Claim 23, wherein said first

pressure vessel has a second opening, said pressure swing adsorption system further comprising:

a second valve manifold comprising:

a second body having a second cavity, a second passage and a second channel, said second cavity being fluidly connected to said second opening of said first pressure vessel, said second passage connecting said second channel to said second cavity, said second channel being in fluid connection with said first channel; and

a second valve provided within said second passage, said second valve being configured to selectively permit and restrict flow between said second channel and said second cavity via said second passage.

46. The pressure swing adsorption system according to Claim 45, wherein;
said first valve manifold is rigidly connected to said first pressure vessel;
said first valve manifold further comprises a first mounting boss having a pin journal adapted for pivotal connection to a support structure;

said second valve manifold is rigidly connected to said first pressure vessel; and
said second valve manifold further comprises a second mounting boss having a pin journal pivotally connected to a linkage that is adapted for pivotal connection to a support structure.

47. The pressure swing adsorption system according to Claim 23, wherein said first passage includes a valve seat and a valve port in which said first valve is received.

48. The pressure swing adsorption system according to Claim 47, wherein said valve seat is concentric with said valve port.

49. The pressure swing adsorption system according to Claim 23, wherein said first valve includes a valve seal configured to be selectively actuated between a sealed contact

position with a valve seat in said first passage wherein said first channel is sealed from said first cavity and a non-contact position with said valve seat, said first valve further including a secondary seal member having a metering orifice.

50. The pressure swing adsorption system according to Claim 23, wherein said first valve comprises:

- a non-return valve;
- a metering orifice provided in parallel with said non-return valve; and
- an on/off valve provided in series with said non-return valve and said metering orifice.

51. The pressure swing adsorption system according to Claim 50, wherein:
said non-return valve comprises a seal cup configured to receive said on/off valve therein;

- said metering orifice is provided through said seal cup; and
- said seal cup is spring biased toward a valve seat provided in said first passage.

52. The pressure swing adsorption system according to Claim 50, wherein said first valve includes a motive device configured to linearly actuate said on/off valve in contact with and out of contact with a valve seat provided in said first passage.

53. A pressure swing adsorption system comprising:

- a pressure vessel having an opening; and
- a valve manifold comprising:
 - a body having a cavity, a passage and a channel, said cavity being fluidly connected to said opening of said pressure vessel, said passage connecting said channel to said cavity; and
 - means for selectively permitting and restricting fluid flow between said

channel and said cavity.

54. A method of performing pressure swing adsorption comprising the steps of:
providing a valve manifold a cavity, a passage and a channel, the cavity being fluidly connected to an opening of the adsorbent vessel, the passage connecting the channel to the cavity, wherein the valve manifold includes a valve provided within the passage, the valve being configured to selectively permit and restrict flow between the channel and the cavity via the passage, the valve comprising a non-return valve, a metering orifice provided in parallel with the non-return valve, and an on/off valve provided in series with the non-return valve and the metering orifice,

wherein product gas flows out of the adsorbent vessel through the non-return valve, the metering orifice and the on/off valve during an adsorption stage,

wherein the product gas flows through the on/off valve and the metering orifice and into the adsorbent vessel during a counter-current flow stage, and

wherein flow to and from the adsorbent vessel ceases when the on/off valve is closed.

55. The method according to Claim 54, wherein the valve manifold comprises at least two valves configured to control fluid flow from the cavity to the channel that is connected to another adsorbent vessel.

56. The method according to Claim 54, wherein:

the non-return valve comprises a seal cup configured to receive the on/off valve therein;

the metering orifice is provided through the seal cup; and

the seal cup is spring biased toward a valve seat provided in the passage.

57. The method according to Claim 54, wherein the on/off valve is linearly actuated in contact with and out of contact with a valve seat provided in the passage.